

CLAIMS

WHAT IS CLAIMED IS:

- 1 1. An optoelectronic device comprising:
2 a multilayer semiconductor structure including an InP
3 substrate and an active region, the active region comprising at least a
4 hole quantum well layer of a semiconductor containing antimony and at
5 least one electron quantum well layer adjacent to the hole quantum well
6 layer which comprises a semiconductor containing nitrogen to provide a
7 type II quantum well structure.
- 1 2. The device of Claim 1 wherein the semiconductor
2 containing antimony is GaAsSb or InGaAsSb and the semiconductor
3 containing nitrogen is InAsN or InGaAsN.
- 1 3. The device of Claim 2 wherein there is an electron
2 quantum well layer on each side of the hole quantum well layer and there
3 is a barrier layer adjacent to each electron quantum well layer on each
4 side of the hole quantum well layer to provide a conduction band profile
5 for the active region having a W-shaped configuration.
- 1 4. The device of Claim 3 wherein the electron quantum
2 well layers are in compressive strain and the hole quantum well layer is in
3 compressive strain.
- 1 5. The device of Claim 3 wherein the electron quantum
2 well layers are in compressive strain and the hole quantum well layer is in
3 tensile strain.

1 6. The device of Claim 3 wherein the thickness of each
2 electron quantum well layer and hole quantum well layer is between
3 approximately 10 and 50 angstroms.

1 7. The device of Claim 3 wherein the barrier layers
2 comprise GaInP.

1 8. The device of Claim 1 wherein the electron quantum
2 well layers and hole quantum well layer form a first quantum well stage,
3 and wherein the active region comprises a plurality of quantum well
4 stages adjacent to each other each having electron quantum well layers
5 surrounding a hole quantum well layer.

1 9. The device of Claim 8 including a barrier layer between
2 each quantum well stage to provide a conduction band profile having a W-
3 shaped configuration.

1 10. The device of claim 9 wherein the barrier layer
2 between each quantum well stage comprises GaInP.

1 11. The device of Claim 1 including means for providing
2 optical feedback to form an edge-emitting laser.

1 12. The device of Claim 1 including means for providing
2 optical feedback to form a vertical cavity surface emitting laser.

1 13. The device of Claim 1 wherein the active region
2 generates light having a wavelength greater than approximately 2 μm .

1 14. The device of Claim 1 wherein the active region
2 generates light having a wavelength of approximately 3 μm .

1 15. The device of Claim 1 wherein the nitrogen content of
2 the electron quantum well is 10% or less.

1 16. An optoelectronic device comprising:
2 a multilayer semiconductor structure including an InP
3 substrate and an active region, the active region comprising at least a
4 hole quantum well layer of GaAsSb or InGaAsSb and an electron quantum
5 well layer of InAsN or InGaAsN on each side of the hole quantum well
6 layer to provide a type II quantum well structure.

1 17. The device of Claim 16 wherein the electron quantum
2 well layers are in compressive strain and the hole quantum well layer is in
3 compressive strain.

1 18. The device of Claim 16 wherein the thickness of each
2 electron quantum well layer and hole quantum well layer is between
3 approximately 10 and 50 angstroms.

1 19. The device of Claim 16 including a barrier layer
2 adjacent to each electron quantum well layer to form a conduction band
3 profile having a W-shaped configuration.

1 20. The device of Claim 19 wherein the barrier layer
2 comprises GaInP.

1 21. The device of Claim 16 wherein the electron quantum
2 well layers and hole quantum well layer form a first quantum well stage,
3 and wherein the active region comprises a plurality of quantum well
4 stages adjacent to each other.

1 22. The device of Claim 21 including a barrier layer of
2 GaInP between each quantum well stage to form a conduction band
3 profile having a W-shaped configuration.

1 23. The device of Claim 16 wherein the percentage of Ga
2 content of the electron quantum well layers is no more than 30%.

1 24. The device of Claim 16 including means for providing
2 optical feedback to form an edge-emitting laser. .

1 25. The device of Claim 16 including means for providing
2 optical feedback to form a vertical cavity surface emitting laser.

1 26. The device of Claim 16 wherein the nitrogen content
2 of the electron quantum wells is 10% or less.

1 27. An optoelectronic device comprising:
2 a multilayer semiconductor structure including an InP
3 substrate and an active region, the active region comprising at least a
4 hole quantum well layer of GaAsSb and a electron quantum well layer of
5 InAsN on each side of the hole quantum well layer to provide a type II
6 quantum well structure wherein the electron quantum well layers are in
7 compressive strain and the hole quantum well layer is in compressive
8 strain.

1 28. The device of Claim 27 wherein the electron quantum
2 well layers are lattice matched to InP.

1 29. The device of Claim 27 wherein the thickness of each
2 electron quantum well layer and hole quantum well layer is between
3 approximately 10 and 50 angstroms.

1 30. The device of Claim 27 including a barrier layer
2 adjacent to each electron quantum well layer to form a conduction band
3 profile having a W-shaped configuration.

1 31. The device of Claim 30 wherein the barrier layers
2 comprise GaInP.

1 32. The device of Claim 27 wherein the electron quantum
2 well layers and hole quantum well layer form a first quantum well stage,
3 and wherein the active region comprises a plurality of quantum well
4 stages adjacent to each other.

1 33. The device of Claim 27 including a transitional layer of
2 GaInP between each quantum well stage.

1 34. The device of Claim 27 including means for providing
2 optical feedback to form an edge-emitting laser.

1 35. The device of Claim 27 including means for providing
2 optical feedback to form a vertical cavity surface emitting laser.

1 36. The device of Claim 27 wherein the active region
2 generates light having a wavelength greater than approximately 2 μm .

1 37. The device of Claim 27 wherein the active region
2 generates light having a wavelength of approximately 3 μm .

1 38. The device of Claim 27 wherein the nitrogen content
2 of the electron quantum wells is 10% or less.

1 39. A semiconductor laser comprising:

2 (a) a multilayer semiconductor structure including an InP
3 substrate and an active region, the active region comprising at least a
4 hole quantum well layer of a semiconductor containing antimony and at
5 least one electron quantum well layer adjacent to the hole quantum well
6 layer which comprises a semiconductor containing nitrogen to provide a
7 type II quantum well structure; and

8 (b) means for providing optical feedback to provide lasing
9 action in the active region.

1 40. The laser of Claim 39 wherein there is an electron
2 quantum well layer on each side of the hole quantum well layer and there
3 is a barrier layer adjacent to each electron quantum well layer on each
4 side of the hole quantum well layer to provide a conduction band profile
5 for the active region having a W-shaped configuration.

1 41. The laser of Claim 40 wherein the semiconductor
2 containing antimony is GaAsSb or InGaAsSb and the semiconductor
3 containing nitrogen is InAsN or InGaAsN.

1 42. The laser of Claim 40 wherein the electron quantum
2 well layers are in compressive strain and the hole quantum well layer is in
3 compressive strain.

1 43. The laser of Claim 40 wherein the electron quantum
2 well layers are in compressive strain and the hole quantum well layer is in
3 tensile strain.

1 44. The laser of Claim 40 wherein the thickness of each
2 electron quantum well layer and hole quantum well layer is between
3 approximately 10 and 50 angstroms.

1 45. The laser of Claim 40 wherein the barrier layer
2 comprises GaInP.

1 46. The laser of Claim 40 wherein the electron quantum
2 well layers and hole quantum well layer form a first quantum well stage,
3 and wherein the active region comprises a plurality of quantum well
4 stages adjacent to each other each having electron quantum well layers
5 surrounding a hole quantum well layer.

1 47. The laser of Claim 46 including a barrier layer of GaInP
2 between each quantum well stage.

1 48. The laser of Claim 39 wherein the means for providing
2 optical feedback forms an edge-emitting laser.

1 49. The laser of Claim 39 wherein the means for providing
2 optical feedback forms a vertical cavity surface emitting laser.

1 50. The laser of Claim 39 wherein the active region
2 generates light having a wavelength greater than approximately 2 μm .

1 51. The laser of Claim 39 wherein the active region
2 generates light having a wavelength of approximately 3 μm .

1 52. The laser of Claim 39 wherein the nitrogen content of
2 the electron quantum wells is 10% or less.